

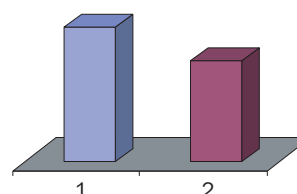
NUCLEAR POWER

PROGRAMME OBJECTIVE

To assist Member States, at their request, in planning and implementing programmes for the utilization of nuclear power, as well as to support them in achieving improved safety, reliability and economic cost effectiveness of their nuclear power plants by promoting advanced engineering and technology, training, quality assurance and infrastructure modernization.

Regular budget expenditure: \$3 903 485

*Extrabudgetary programme expenditure
(not included in chart): \$90 194*



1. Nuclear Power Planning, Implementation and Performance: \$2 231 926
2. Nuclear Power Reactor Technology Development: \$1 671 559

OVERVIEW

The Agency's nuclear power programme in 2000 reflected the growing emphasis on economic competitiveness arising from liberalizing electricity markets around the world. A number of documents were published and databases further expanded, containing information, recommendations and guidance formulated under the aegis of the Agency on proven engineering and management practices for achieving improved safety, reliability and economic cost effectiveness of nuclear power plants. These were also made available in electronic form and widely distributed to the end users in Member States.

Innovation is key to the future role of nuclear power, and successful innovation will require substantial investments around the world. The Agency can facilitate international exchange and co-operation in this area so that such efforts are more likely to reinforce and complement each other in a cost effective manner. The recommendation of a number of high level advisory groups and expert panels and recent programme activities on innovative concepts led in November to an agreement among a number of Member States to establish the new International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO). This project will build upon continuing programme activities on new technologies and applications, including small and medium sized reactors, evolutionary improvements in water cooled reactors, fast reactors, high temperature modular gas cooled reactors and desalination applications.

NUCLEAR POWER PLANNING, IMPLEMENTATION AND PERFORMANCE

The Agency published a number of guidebooks and monographs in 2000 to assist Member States in planning, implementing and operating nuclear power projects:

- Planning issues were dealt with in a revised edition of the guidebook *Economic Evaluation of Bids for Nuclear Power Plants*, together with upgrades to the associated computer program. The new guidebook and software reflect feedback from Member States based on experience with the 1986 edition of the guidebook.
- In the area of personnel training, *Analysis Phase of Systematic Approach to Training (SAT) for Nuclear Plant Personnel* describes alternative methods of job analysis and provides practical examples from Member States.
- *Quality Assurance Standards: Comparison Between IAEA 50-C/SG-Q and ISO 9001:1994*, produced in collaboration with FORATOM, clarifies technical differences between Agency and ISO standards to help ensure that applications of ISO standards to nuclear installations are fully compatible with regulatory requirements. A technical report, *Quality Assurance for Software Important to Safety* addresses the increasing importance of software applications in the design, testing and analysis of nuclear reactor systems, as well as in monitoring, control and safety functions. *Managing Suspect and Counterfeit Items in the Nuclear Industry* provides guidance on identifying and handling components that appear not to conform to established specifications and standards (suspect items) and may also be illegal copies or substitutes whose material, performance or characteristics are knowingly misrepresented by the vendor, supplier, distributor or manufacturer (counterfeit items).
- *Strategies For Competitive Nuclear Power Plants* provides plant managers with information and methods to identify and implement measures to remain competitive in the midst of rapid changes in electricity markets around the world. A technical

report on the Agency's Nuclear Economic Performance International System (NEPIS) summarizes the major transformations occurring in the electricity generation industry that require reduced nuclear operations and maintenance costs, and resource optimization methods that nuclear plant managers can use in response. The report also identifies difficulties that existing cost accounting systems create for data collection and offers suggestions for new systems.

- *Management of Ageing of Instrumentation and Control Equipment in Nuclear Power Plants* analyses experience with ageing components around the world. In addition, using different management techniques, it presents a suggested ageing management strategy and outlines the necessary steps toward practical implementation.

In 2000, the Agency released the Power Reactor Information System (PRIS), including mapping features and the full database, on CD-ROM and through the PRIS Web page (<http://www.iaea.or.at/programmes/a2/>). Two PRIS services, MicroPRIS and PRIS-PC (the connection to PRIS through the Internet), are currently distributed to more than 600 users in Member States and international organizations.

Over the past few years, the number of technical co-operation projects has increased significantly. In 2000, two large regional projects were completed in Europe on improving operations management and in-service inspection of WWER-440/1000 reactors. Other projects provided technical support for preparations for new nuclear power plant projects in Africa, Asia, Europe and Latin America, life management of power plants in Europe and Latin America, personnel training and qualification in the Commonwealth of Independent States, and modernization of instrumentation and control in Europe and Latin America.

NUCLEAR POWER REACTOR TECHNOLOGY DEVELOPMENT

In November, senior officials from Member States and international organizations met in

Vienna to establish the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) and finalize its terms of reference. These include:

- Helping to make nuclear energy available for meeting the sustainable energy needs of the 21st century;
- Facilitating information exchange and joint consideration by interested Member States, including both technology suppliers and users, of international and national actions to advance innovations in nuclear reactors and fuel cycles that improve economics, safety, proliferation resistance and environmental soundness;
- Engaging all relevant stakeholders in a process that builds on and complements existing national and international initiatives.

INPRO will be implemented through an International Co-ordinating Group on Innovative Nuclear Reactors and Fuel Cycles (ICG), established for a period of two years. The ICG will have a steering committee and be supported by technical expert groups from Member States, with project management and administration support from the Agency.

The Agency's Technical Working Group on Advanced Technologies for Light Water Reactors focuses on technology developments to improve the economic competitiveness of LWRs while meeting stringent safety objectives. A Technical Committee meeting in Munich in October on the performance of operating and advanced LWR designs showed that technological improvements in inspection, maintenance and repair make important contributions to higher performance and better economic competitiveness of existing nuclear power plants. Similar benefits were seen from economies of scale, design optimization and standardization for new evolutionary designs.

Within the framework of the Agency's Technical Working Group on Advanced Technologies for Heavy Water Reactors (TWG-HWRs), a technical document was completed that examines the status of HWR advanced technology in the areas of fuel cycle flexibility, safety and

economics, and advanced technology development needs in the coming two decades. It also forms a basis for definition of the TWG's future activities. The document addresses both evolutionary and innovative HWRs, and will provide input to INPRO.

Natural circulation phenomena play a particularly important role in the design of passive systems, a feature that can improve economics and safety in evolutionary and innovative nuclear power plants. A Technical Committee meeting assessed the current base of experimental data and the applicability of current

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methodologies for computing natural convection phenomena in advanced water cooled reactor designs, and developed approaches to carrying out improvements in models and supporting experimental data. The information from this meeting will form one of the many technical inputs to INPRO.

For sodium cooled reactors, previous Agency-European Commission joint benchmark exercises have shown that large conventional, sodium cooled fast reactor cores show reactivity increases if coolant is lost by boiling or gas intrusion. Since even a small positive reactivity effect has an important safety impact, a number of research teams around the world are investigating ways to neutralize the positive sodium void reactivity effect. Doing so through innovative core designs has the advantage of providing an additional inherently activated safety margin to prevent fuel pin failure or local boiling in the domain of operational and severe transients. Through a new joint benchmark programme, the Agency and the European Commission jointly studied the possibility of replacing the core's upper axial blanket with a sodium plenum to

enhance axial neutron leakage. This approach resulted in a strong negative reactivity effect.

In order to generalize, review and document fundamental knowledge in liquid metal cooled reactor technology, the Agency completed a

“A Web site launched in 2000 provides an overview of gas cooled reactor (GCR) technology development and related Agency activities ...”

technical report on the main design and technical problems that have occurred during liquid metal fast reactor operation. The report included findings on how to avoid past design errors and incorporate effective solutions to problems that have already occurred.

International interest and activity in modular high temperature gas cooled reactors (HTGRs) increased in 2000. The Chinese HTR-10 experimental reactor went critical in December, and the HTTR in Japan continued power ascension testing. The South African ESKOM Pebble Bed Modular Reactor received active project participation from British Nuclear Fuels Ltd. in the United Kingdom and Exelon in the USA. And work on the Gas Turbine Modular Helium Reactor continued, with participation from France, Japan, the Russian Federation and the USA. A number of additional design feasibility studies are also under way.

A Web site launched in 2000 provides an overview of gas cooled reactor (GCR) technology development and related Agency activities (<http://www.iaea.org/inis/aws/htgr/index.html>). A second related site facilitates information exchange and collaboration among the chief scientific investigators in a CRP on the evaluation of high temperature GCR performance. The CRP's objectives are to validate analytical codes and performance models, formulate code-to-experiment benchmark activities for the test programmes,

demonstrate GCR safety characteristics and evaluate research synergism in the commissioning of the HTTR and HTR-10 plants.

Following General Conference Resolution GC(44)/RES/22, a software manual for the Agency's Desalination Economic Evaluation Program (DEEP) was published, including technical descriptions, flowcharts of all calculation modules and installation instructions. Available on CD-ROM, the software and manual have been distributed to 96 experts in 30 Member States. In addition, 50 licenses for DEEP had been granted by the end of 2000.

Examining the Economics of Seawater Desalination Using the DEEP Code, published in 2000, provides a comprehensive economic assessment of nuclear desalination compared with fossil options and lays the basis for future case specific evaluations for national projects and studies. *Guidance for Preparing User Requirements Documents (URDs) of Small and Medium Size Reactors and its Application in Developing Countries* addresses the possible use of such reactors for desalination in developing countries. These publications will support the Agency's objective of facilitating collaborative, interregional technical co-operation projects involving technology holders and end-users, leading to an integrated nuclear desalination system generating both power and heat.

The International Nuclear Desalination Advisory Group (INDAG) held its fourth meeting in April 2000 and reviewed recent developments both inside and outside the Agency. Among other observations, INDAG recommended strengthening the Agency's generic tools for planning and implementing nuclear desalination projects in developing countries. Based on its review of outside activities, INDAG urged more active participation by developing countries, in particular, in the interregional technical co-operation project on integrated nuclear and desalination system design. In related work, a Web page was set up that provides for INDAG information on the technology of nuclear seawater desalination, past and present projects, Agency activities, and sample calculations using DEEP.